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OBSERVATIONS ON PREDATORS AND PREY AT ERAVIKULAM NATIONAL PARK, KERALA¹

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(With six text-figures)

Antipredator strategies of Nilgiri tahr (*Hemitragus hylocrius*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), and Nilgiri langur (*Presbytis johni*) are described. Habitat use, hunting and killing methods, and prey selection are presented for tiger (*Panthera tigris*), leopard (*P. pardus*), Asiatic wild dog (*Cuon alpinus*), jackal (*Canis aureus*), and humans. Observations and evidence from droppings indicated that tiger, leopard, and wild dog all preyed most frequently on sambar. Leopard and wild dog also preyed on Nilgiri tahr. Observations from Eravikulam National Park are used as a basis for the discussion of some general concepts of antipredator behavior.

INTRODUCTION

The study of predator-prey interactions of large mammals in the Indian sub-continent has been hampered by the problems of making observations on animals in thick forests, shy subjects (both predators and prey), and the solitary and nocturnal habits of many of the predators. The open, rolling grassland of Eravikulam National Park provided opportunity for

observing a diversity of predators and prey. Although the shyness of the predators remained a problem, the observations presented here give some further insight into relations between large predators and their prey in this region.

STUDY AREA

Eravikulam National Park is located in the High Range of the Western Ghats north of Munnar, Kerala. The area was previously part of the land of the Kanan Devan Hills Produce Corporation (now Tata Tea), but was declared a sanctuary in 1975, and upgraded to a national park in 1978.

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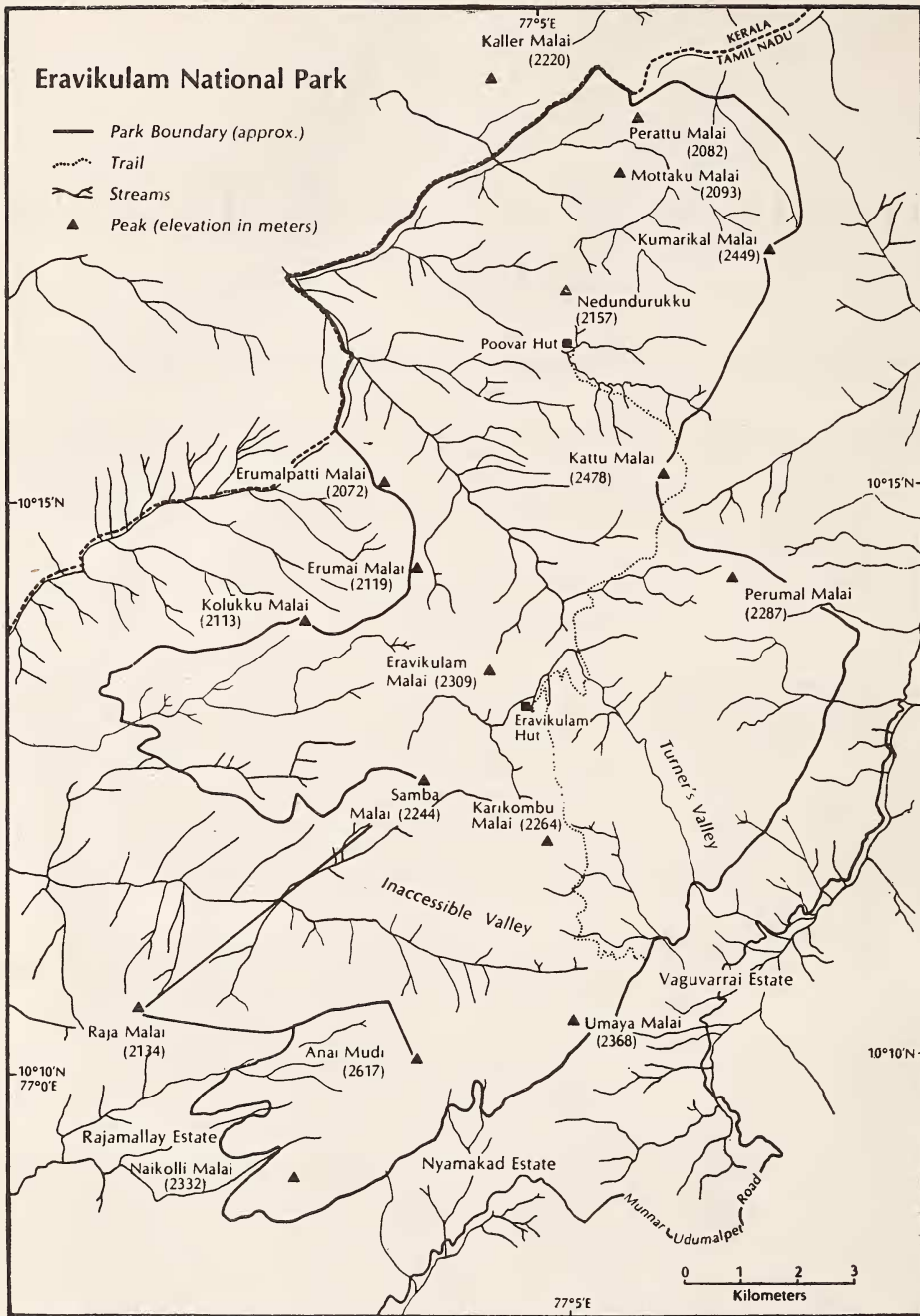


Fig. 1. Approximate boundary of Eravikulam National Park. From Rice 1984.

The main body of the park is comprised of a high rolling plateau, with a base elevation of about 2,000 m. The plateau is split roughly in half from northwest to southeast by Turner's Valley, which has a maximum depth (within the park) of about 600 m. Knolls and hills generally rise up to 500 m above the plateau, although Anai Mudi, the highest point in India south of the Himalayas, reaches 2,697 m. The fringes of the plateau are frequently precipitous, often with broken cliffs and steep slopes. However, the cliffs are usually not abrupt, but rounded both vertically and horizontally. For the most part, the park boundary is coincident with the edge of the plateau. The main physical and political features of Eravikulam National Park are shown in Fig. 1.

Three major types of plant communities are found within Eravikulam National Park; grassland, shrubland, and forest. As is typical for most of the Western Ghats, terrain over about 2,000 m is primarily covered by grassland, and there are numerous small patches of forest in hollows and gullies. The deeper valleys are extensively forested, while shrublands predominate along the bases of the cliffs and are interspersed in rocky slab areas. Patches of forest are locally known as sholas.

Large mammals found within the park are Nilgiri tahr (*Hemitragus hylocrius*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), barking deer (*Muntiacus muntjak*), Asiatic elephant (*Elephas maximus*), tiger (*Panthera tigris*), leopard (*P. pardus*), Asiatic wild dog (*Cuon alpinus*), jackal (*Canis aureus*), jungle cat (*Felis chaus*), stripe-necked mongoose (*Herpestes viticollis*), Nilgiri langur (*Presbytis johni*), and humans.

The annual weather cycle is dominated by the monsoon. Of the average annual rainfall total of 405 cm, about three-fourths falls during the monsoon months of June, July, and

August. Sunshine is rare during the monsoon, and strong westerly winds, up to gale force, are the rule. At Eravikulam the post-monsoon (sometimes called the northeast monsoon) lasts from September through December. Rainfall is considerably diminished (about 25 cm/month), with moderate and variable winds. Mist commonly engulfs the hills during both the monsoon and post-monsoon. There is little rainfall during the winter (January and February), and the skies are usually clear. Winds are moderate to light, and mostly from the east. As the pre-monsoon proceeds (March through May), thundershowers become more and more frequent, while moderate easterly winds still predominate. For more detailed information on the history, physiography, plant ecology, and weather of Eravikulam, see Shetty and Vivekananthan 1971, Subramaniam and Nayar 1974, and Rice 1984.

METHODS

This report is based on observations made during a study on the behavior and ecology of Nilgiri tahr conducted from 8 August 1979 to 26 September 1981 (Rice 1984). During the second half of the study many observations were made on a habituated subpopulation of about 120 tahr. For the purposes of this report, Nilgiri tahr are divided into the following sex and age classes: young—less than one year old; yearling—one year old; female—female two years or older; light brown male—male two to three years old; large light brown male—male four years old; dark brown male—male five years old; and saddleback—male six years or older.

Observations on predators and other prey species in the park were made whenever opportunity presented itself. Indirect evidence was obtained from examining predator kills.

For recent kills, the predator involved could often be identified by examining the kill and the surrounding ground. For instance, the wild dog's propensity for killing sambar in the water usually left little doubt as to their involvement. Toothmarks or the manner in which the prey had been consumed were also important indicators. In other cases droppings or tracks in the vicinity implicated a certain predator. Predator droppings were also examined for prey remains.

PREY

Nilgiri tahr

About 550 Nilgiri tahr inhabit Eravikulam National Park, making it the largest wild population (Rice *in press*). The tahr generally inhabited the fringes of the grassy plateau, but also moved onto the steep slabs and cliffs bordering it. They occasionally visited the shrublands along the base of the cliffs. Tahr generally avoided sholas, but sometimes foraged along their periphery. Nilgiri tahr at Eravikulam occurred in large groups, numbering up to 150 individuals. Adult males separated from mixed groups outside the rut, and often ranged outside the areas used by the mixed groups (Rice 1984). Most tahr were born in January and February, but some births occurred early in the spring and during the monsoon.

The vision of Nilgiri tahr seemed to be about on par with my own, as they seemed to discern distant animals at about the same distance as I could. Their hearing too, seemed comparable to mine, although this was more difficult to gauge. The sense of smell of the tahr, on the other hand, was evidently quite good. One had to take the wind into account when approaching tahr, and once several tahr turned and oriented upwind as two men pass-

ed by on a trail out of sight a couple of hundred metres away.

The tahr's predilection for the plateau margins probably represents a compromise between the advantages of access to the better grazing in the grassland, and ready access to precipitous terrain. When disturbed in grassland, Nilgiri tahr generally moved directly towards the nearest set of cliffs, at a gallop if the danger was immediate, or more slowly if the threat was more remote. The tahr appeared to have an excellent mental map of the terrain they occupied, and took flight in the appropriate direction almost without fail. A notable exception was when a number of animals from another area joined a group of habituated tahr. Presumably because they were unfamiliar with the terrain, the new animals took flight directly away from me rather than onto the nearby cliffs. What happened once the tahr were on the rock slabs depended greatly on what predator was involved (see below). I never saw tahr take flight into a shola. When not running at full speed, alarmed tahr typically ran with a pronounced rocking horse-like gait, striking the ground forcefully with both fore and hind legs. An alert tahr stood in erect posture, with the neck raised above the normal posture. When on a slope, the tahr extended the neck laterally as well to obtain a better view along the slope (see photo in Schaller 1971).

All of the above reactions were effective in communicating a tahr's aroused state to other tahr. In addition, tahr performed distinctive displays which also served this function. The conspicuous sneeze-whistle is produced by expelling air forcefully through the nostrils, and has a sharp, high, thin, airy quality. Loud whistles could be heard up to 1 km away. The tahr involved generally whistled from a stationary alert posture, making it difficult to

distinguish which individual was whistling if several animals were alert. Whistling evidently indicated a high level of arousal in a tahr, either from not being able to clearly identify an intruder, or upon observation of a predator at close proximity. The whistle was also sometimes given by an estrous female when closely and vigorously courted by males, which indicates that it signified anxiety or agitation rather than specifically alarm or fear.

The foreleg stamp was another indication of an agitated state in Nilgiri tahr. This was evidently both an auditory and visual signal, as the stamp could be heard by nearby animals, and the sudden movement contrasted conspicuously with the otherwise stationary alert posture. Nilgiri tahr did not raise their tails in this context.

I recorded the sequence and timing of whistling and stamping of one female located on the periphery of a group on 28 March 1980. At 1029 h she became alert and began whistling in response to an unidentified stimulus. Figure 2 shows the sequence of whistles and stamps starting four minutes later, and until she turned and moved away at 1103 h. In those 30 min she whistled a total of 79 times, stamped 43 times, and the stamp and whistle were simultaneous 26 times. Although stamps were less frequent than whistles, they both showed a similar pattern, suggesting that both increase with increasing excitement. In addition, the per cent of whistles accompanied by stamps was also closely correlated with the frequency of whistling and stamping.

The response of other tahr to these signals varied somewhat with the circumstances. Generally they oriented in the same direction as the alerted animal, and sometimes moved to gain the same viewpoint if they could not discern the cause. However, alarm of this type was only temporarily contagious, and

tahr that did not confirm the need for alarm soon lost interest. This was evident when an unhabituated individual in a habituated group (such as a newly arrived male), became alarmed at my arrival. As soon as the habituated tahr ascertained that I was the stimulus for the arousal, they resumed their normal behavior. The lack of alarm in the habituated tahr also had a contagious effect on unhabituated tahr, and this served to habituate a new arrival almost completely within one week. Similarly, when the female whose alarm signals are depicted in Fig. 2 began her whistling, the whole group rose, and several tahr from the group above came down behind her. However, unable to discern the cause, they began grazing within 3 min, and many rested by 7 min after the onset. Then, as the female resumed frequent whistling at 19 min, some again rose, only to rest again at 25 min. The female turned and moved up to them at 30 min.

Further details of alarm behavior are given below in the descriptions of interactions with predators. Flight and defense also varied considerably between the predator species and will be described in that section.

Sambar

Unlike Nilgiri tahr, sambar are primarily an inhabitant of forests. However, they did come out onto the grassy slopes to graze, particularly in the early morning and late evening. Although I never saw them there, sign indicated that sambar used the extensive grass areas of the central plateau during the night. They also frequented the shrublands along the base of cliffs. Sambar were generally seen alone or in small groups of around a half a dozen. Occasionally they came together in groups of a dozen or more. At Eravikulam sambar gave

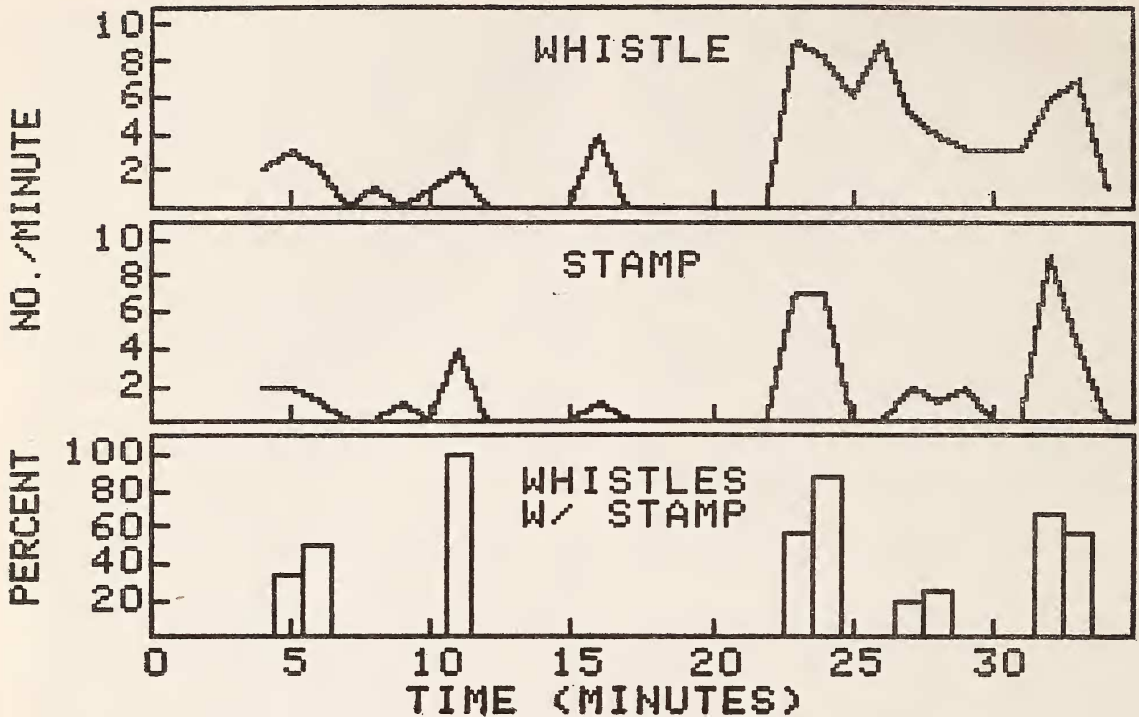


Fig. 2. Number of whistles and stamps per minute and percent whistles coinciding with stamps given by an adult female Nilgiri tahr in response to an unidentified disturbance. Starting time: 1129 h, 18 March 1980.

birth in the post-monsoon, indicating a rut during the pre-monsoon.

The vision of sambar seemed somewhat less acute than that of tahr, at least over long distances. Sambar are reputed to have an excellent sense of smell (Johnsingh 1983).

In direct contrast to tahr, sambar typically took flight into sholas when disturbed. Their alert posture was essentially the same as the tahr's. The sambar's alarm call is a loud, hoarse, brief vocalization (Schaller 1967, Johnsingh 1983), audible over long distances. Sambar called, sometimes repeatedly, in similar contexts as the tahr whistled.

Sambar also stamped a foreleg when agitated, but often kept the foreleg raised for a second or two before stamping. When agitated

and in flight sambar raised their tails, exposing the light colored hairs under the tail. Further information on sambar's reaction to predators is given in the section on predators.

Gaur

Like sambar, the gaur is primarily a forest animal. Gaur, however, generally remained in the vicinity of sholas when grazing although they did occasionally move across extensive grasslands. They travelled in groups of up to about 30.

The vision of gaur is reputedly poor (Krishnan 1975, Prater 1980), and my experience suggested that this was true. Their sense of smell, however, is exceptionally good (Schaller 1967).

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Gaur also took flight directly into sholas. Other than orienting (at least the head) toward the source of disturbance and flight, gaur showed no marked signs of agitation, although Schaller (1967) mentions snorting and "growling" and Wemmer (pers. comm.) noted a loud, hissing snort in this context.

Nilgiri langur

Nilgiri langur were often seen in the extensive valley forests, but also made their way to isolated sholas in the highlands. They rarely moved out of the trees to feed in the adjacent grassland. I was generally unable to count the number of animals, but most groups seemed to be of about a dozen.

An alert Nilgiri langur usually sat upright on a branch and oriented toward the distur-

bance. The typical response to evident danger was the gruff bark (Poirier 1970), a sharp, loud cough, a series of which often ended in a whoop. Although I never saw humans pursuing Nilgiri langur, they were reportedly sometimes killed as their flesh is reputed to be beneficial in treating respiratory ailments.

Other species

Muntjac and elephants were both seen a few times during the study. The muntjac rarely left the valley sholas, although I did hear their alarm call (Wiles & Weeks 1981) on occasion. Elephants passed through the area from time to time, usually crossing the plateau in the course of a night. I observed no interactions between predators and either of these two species.

TABLE 1
NUMBER OF OBSERVATIONS ON PREDATORS DURING THIS STUDY IN ERAVIKULAM NATIONAL PARK

	Tiger	Leopard			Wild dog	Jackal	Human
		Black	Spotted	Both			
Sign:							
Tracks	43	-	-	8	2	4	-
Scrape	2	-	-	9	-	-	-
Sightings:							
Total	10	6	3	10	18	24	8
In tahr							
home range	4	6	3	10	11	11	2
Apparently hunting:							
Tahr		2	2	4	8		2
Sambar	1	1		1	4		1
Attack:							
Tahr		1	2	3	7		1
	1				2		
Kill observed:							
Tahr			1	1	6		1
Sambar					1		
Kills attributed:							
Tahr				1	1		1
Sambar	1				13		
Gaur	1						

THE PREDATORS AND THEIR INTERACTIONS
WITH PREY

A summary of observations on predator species made during the study is shown in Table 1. The number of sightings refers to the total number of times a species of predator was seen, regardless of the number of individuals involved. The number of interactions, on the other hand, reflects the number of interactions with any one prey, including multiple chases and kills. The occurrence of prey remains in predator droppings collected during the study is given in Table 2.

TABLE 2

PERCENT OCCURRENCE OF PREY REMAINS IN PREDATOR
DROPPINGS COLLECTED DURING THIS STUDY FROM
ERAVIKULAM NATIONAL PARK

	Tiger	Asiatic		Jackal
		Leopard	Wild dog	
Gaur				1
Sambar	94	38	90	6
Nilgiri tahr		29	8	1
Barking deer	11	10	5	1
Nilgiri langur		27		
Porcupine		4		
Rodent		6		91
Bird				6
Lizard or Snake		6	3	31
Crab				1
Insect		4		10
No. of droppings	18	48	40	139

Tiger

Tiger are not numerous at Eravikulam National Park, as one might expect considering the elevation, rough terrain, and open habitat. In fact, all five of the tiger sightings in which I could see the facial markings were of the same female. These enclosed an area of 11

km². All of my sightings were of solitary tigers (Table 3), but Wildlife Preservation Officer M. Alambuth (pers. comm.) encountered a subadult tiger and tracks of an adult and subadult on the north side of Kattu Malai. Whether this was the same individual female is uncertain. I encountered tiger tracks much more frequently than those of other predators, on a total of 43 occasions (Table 1). This is probably more an indication of their propensity to travel man-made roads (Schaller 1967, Seidensticker 1976, Sunquist 1981), than it is an indication of their abundance or level of activity in the area. Tiger scrapes, on the other hand, were rarely encountered.

Of the 11 tiger sightings, only 4 were in tahr home range, and in none of these cases did the tiger appear to be hunting tahr. I observed tahr and tiger encounters three times, all apparently by coincidence. On 29 March 1981, a group of 27 tahr were climbing a ridge on the northeastern flank of Turner's Valley. At 1130 h a tiger casually crossed the west side of a knoll about 250 m ahead of them. Although the tiger did not seem to notice the tahr, they saw the tiger. They did not show a strong alarm reaction at that distance, but did cease their movement, and by 1200 h they had reversed their direction. On another occasion, however, the tahr showed more obvious arousal, including whistles, as they watched a tigress traverse the opposite slopes of a ravine, about 200 m away.

Another encounter occurred when a tiger climbed out of a ravine, surprising a group of tahr on a grassy ridge top during a rain shower on 19 June 1981. The first tahr to see the tiger, a female resting on the group's perimeter, jumped up and ran directly away from the tiger, and as the tiger came into full view, the entire group dashed off, and then kept moving, running and walking, until I

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TABLE 3

PERCENT SIGHTINGS OF PREDATORS IN EACH GROUP SIZE DURING THIS STUDY, ERAVIKULAM NATIONAL PARK
(EXCLUDES SIGHTINGS FOR WHICH A TOTAL COUNT WAS NOT POSSIBLE)

Predator	Tiger	Leopard	Asiatic Wild dog	Jackal	Human
No./group 1	100	82	1	60	
2		18	2	40	5
3			3		7
4					9
5					23
6					14
7			7		16
8					
9			87		
10					
11					
12					27
No. animals sighted	11	11	103	30	44
No. of groups	11	10	14	24	8
Mean group size	1.0	1.1	7.4	1.2	5.5

found them 7 min later, standing about 150 m away, still some 75 m from the nearest cliffs. Although the tiger had moved right to this group, it made no attempt to conceal itself, either before being seen by the tahr, or afterwards, despite the availability of cover in the form of numerous *Strobilanthes* shrubs. The interaction, however, was interrupted prematurely when the tiger caught a glimpse of me, at which it turned and slipped back into the ravine from which it had come.

Sambar reacted strongly to a tiger in the open, but did not take flight in the one instance I observed. Rather, as the tiger passed 100 m below them, the sambar stood alert, calling and stamping. As the tiger moved on and out of sight, the sambar moved down and sniffed the grass along the trail.

A tiger was observed pursuing prey only once. The following account was taken from my field notes of 29 March 1981.

1618 h. Sambar start giving alarm calls from a large shola in Turner's Valley at the base of the west side of Poola Malai. A growl, apparently of a tiger, also is heard.

1624 h. Calling continues, at least 20 calls. Tahr grazing low on the opposite slopes move up into a small bowl in the grassland, apparently in response.

1639 h. The tiger is first seen bounding, then moving more slowly across the grassland flats at the base of the valley below the shola. It is following a sambar doe which is moving up the base of Turner's Valley, about 250 m ahead. The sambar doe has a wound on her right hind leg, a large chunk of tissue hanging free, although it does not appear bloody. She continues up the valley, and then turns uphill to enter another shola about 800 m from the first at 1645. The tiger also continues up the valley, swimming through one pool in the stream, and then climbs on to the flats. Walking at a steady pace without hesitating, the tiger follows roughly the same path as taken by the sambar, although it is not obvious if it is following visual or olfactory cues.

1650 h. The tiger also enters the second shola.

1658 h. A series of sambar alarm calls come from the shola. Then 10-20 more at intervals of a few seconds.

1659 h. Having emerged from the side of the shola, the tiger again appears moving down the side of the valley, rounds a grassy ridge, and trots back into the first shola.

1701 h. After passing through the top of the shola, the tiger comes out onto the burned grassland above it, 1702. It is apparently still on the trail of the sambar doe whose movement I seem to have missed from my distant vantage point. The doe is now with several other sambar on the grassy slopes above and ahead of the tiger. Her wound is roughly rectangular in shape, 30 cm down from the base of the tail, 8-10 cm high, and about 6 cm deep at the top and about 4 cm deep at the bottom margin. It has a clean-cut appearance when seen from the side, but tissues approximately equivalent to the displaced volume hang and flap along the inside of her thigh. There is no evidence of any other wounds.

1708 h. Having apparently lost track of the wounded doe, the tiger doubles back, retraces her steps and disappears into the top of the shola.

1716 h. The tiger moans several more times. The doe has continued across and up the slope, and moved from view.

1733 h. The tiger reappears at the top of the shola, sniffing the ground while moving. It climbs in switchbacks up the slope, now 50 m above. As the tiger comes into view the other sambar call. The tiger looks up at them and then doubles back up the valley as the sambar continue to stand and call, even after it moves out of sight.

1741 h. Tiger moans again. It is now just above the shola where it emerged earlier, apparently trying to relocate the wounded sambar's trail.

1750 h. The tiger starts up the slope again, galloping a few strides, then stands. It moves toward the other sambar, then turns back and forth.

1754 h. One of the sambar above sees the tiger and calls. The tiger zigzags around in the grassland, giving a moan. Now about 100 m apart and in plain view of each other the tiger and sambar stand facing each other. The sambar call, but not as persistently as earlier.

1802 h. The tiger seems to be searching the area for the wounded sambar's trail, moving back and forth.

1806 h. The tiger traverses the slope above the sambar and moves to the ridge, stands, and then sits on its haunches.

1809 h. The tiger moves on around the corner out of sight.

1826 h. Sambar alarm calls alert me to the tiger traversing back across the slopes. The tiger moans. The sambar take flight at about 50 m.

1828 h. The tiger moans again, diagonally down across the slope. Six more moans by 1834 h. I lose track of it in the fading light, but moans are still heard until 1856 h.

This would appear to be a rare instance of an extended pursuit by a tiger, much in contrast to the quick and efficient hunting and killing usually attributed to them. However, such a judgment is difficult to make in view of the scarcity of eye-witness accounts of interactions of tiger and wild prey. This scarcity is understandable considering the shyness of the animals and the thickness of the vegetation which they inhabit. Most accounts of killing are of tethered domestic buffalo baits, and are of little use for comparison here (Schaller 1967, McDougal 1977, Sunquist 1981). Nevertheless, it does illustrate that a tiger may pursue its prey for some distance, covering more than 2 km in over 2 h in this case. The wound was presumably inflicted at the initial attack, and was likely an important stimulus for the continuation of the pursuit.

The tiger was probably using its sense of smell when following the sambar doe up the floor of the valley, and certainly seemed to be searching for a scent trail when zig-zagging on the slopes above the shola. Likewise it does not seem likely that the tiger could have kept on the trail of the sambar through so much grassland and forest without being able

to follow the scent trail. This indicates that, as Schaller (1967) has reasoned, that a tiger's sense of smell is fairly good.

I found one fresh sambar kill near a small lake in open grassland which I attributed to tiger. Hairs in tiger droppings gave another indication of the extent to which tiger prey on sambar (Table 2). This evidence supports the observational evidence that tiger do not prey on tahr, but depend primarily on sambar for sustenance. On the other hand, Davidar (1971) found tahr hair in two of the five tiger droppings he examined from the Grass Hills.

While Sunquist (1981) maintains that gaur are "virtually invulnerable" to tiger predation by virtue of their large size, this was not the case at Eravikulam. I found one gaur cow on the flats of the central plateau which had evidently been killed by a tiger. She bore numerous canine punctures on both the throat and nape, indicating numerous bites by the tiger, and a claw mark on the shoulder. Sunquist (1981) and McDougal (1977) agree that the nape bite is used by tiger for smaller kills, while the throat bite is used in killing larger animals (over about 90 kg). This tiger had quite obviously used both repeatedly on this very large prey (about 500 kg). Also, of the four tiger droppings I collected in the Grass Hills in 1978, an area where gaur seemed to be more plentiful, three contained gaur hair. Schaller (1967) and Johnsingh (1983) also reported gaur remains in tiger droppings from Kanha National Park and Bandipur Tiger Reserve, respectively.

Leopard

Both black and spotted phases of leopard occurred in Eravikulam National Park. Although the number of sightings of the black phase was more than twice that of the spotted (Table 1), these may be all of two individuals

as they were all within a limited area of about 6 sq km. It is likely that these leopards ranged outside of the area in which I encountered them, and probably used an area similar in size to the 8-10 sq km estimated for leopards at Wilpattu National Park, Sri Lanka (Eisenberg and Lockhart 1972), or Chitwan National Park, Nepal (Seidensticker 1976). If this is the case, Eravikulam National Park could harbor upwards of 10 leopards, with others inhabiting adjacent forested areas. With the exception of one pair, all sightings were of single leopards (Table 3).

Leopard tracks were met with much less frequently than those of tiger, primarily because leopards used man-made trails much less frequently than tiger (see also Sunquist 1981). Most of the tracks I encountered were along a soft dirt game trail along the western rim of Turner's Valley. Leopards also frequently left scrapes in this area, which coincided with the southernmost limit of my observations of the black phase.

In marked contrast to tiger, all leopard sightings were within tahr home range, and they appeared to be hunting tahr on 4 of the 11 sightings. Tahr reacted strongly to the presence of a leopard, but nevertheless, tolerated and even maintained a close proximity to them as is illustrated by the following observations from my field notes:

At 1410 h on 29 April 1980 the tahr I am observing alert me to the presence of a spotted leopard on a rock slab below the grassy slopes we are on. Several tahr cluster at the top edge of the slabs, standing alert and giving numerous whistles. The leopard, without any attempt at concealment, moves across towards the tahr, passing about 10 m below them. At the same time, the tahr at the edge of the slabs mill about, some individuals turning as if to run up the slope, only to turn about and return to the edge of the bluff. The leopard moves out of sight briefly, but the tahr's attention stays on it as it moves around

below. The leopard makes a sudden rush up through a break in the slabs and the tahr scatter as the leopard passes through the group, some turning uphill, others down onto the slabs, but all turn in a tight circle to face the leopard again. The leopard looks up, directly at me 25 m in front of it, sits for a moment, then drops to the ground and slips from view into a small gully at 1420 h.

On 22 May 1980 the tahr again draw my attention to a black leopard with a series of whistles. As I locate it on the slabs across the ravine they are turning to watch it at a distance of 10-15 m, with only rock slabs between them. The leopard runs through the group and past them and around the corner of a ridge. The tahr follow as the leopard moves from view, and cluster tightly at the corner of the ridge, whistling continually. Occasionally some turn and run from the edge, then turn about to join others. In this fashion the tahr "leap-frog" up the ridge, evidently as the leopard moves along the far side at 1220 h.

I move to a vantage point on the other side of the same ridge to find the leopard and tahr looking at each other about 8 m apart. The leopard walks toward some of the tahr, and they, in turn move from it, whistling continually and giving an occasional stamp. At 1303 h the leopard lies down on a grassy ledge, looking at about 15 tahr clustered above, looking back at it. Tahr whistling continues. The leopard rests its head on the grass at 1306 h, then raises and waves its tail, and rises at 1313 h. Tahr renew their whistling. The leopard moves forward and the tahr scatter, keeping about 6 m from it as it moves from view.

Part of the leopard is visible as it rests again, 1317 h. Tahr relax somewhat, look away, and one rests on a slab at only 10 m from the leopard, 1323 h. At 1329 h some of the upper tahr start to drift up the slope. As the leopard crouches, then rises, tahr whistle. 1352 h. (This situation is portrayed in Fig. 3). The leopard yawns, turns and moves from view. The tahr watch as it evidently moves off, follow a bit, and then turn back to the slabs at 1359 h. I estimated the slope of these slabs at 45°, a steepness over which I could move only with great care.

The following generalizations can be drawn from these accounts. The tahr show typical

alarm behavior in the presence of a leopard, including an erect, attentive posture, whistling, and clustering together. However, despite the obvious arousal evidenced by their behavior, the tahr do not flee from a leopard when they encounter it on steep rock slabs, but remain in the vicinity, and keep close watch until it departs.

These accounts also illustrate the importance of surprise for a leopard hunting tahr. Neither leopard seemed to have the slightest chance of obtaining a meal once the tahr were aware of their presence. Surprise appeared to play an important role in the one kill I did observe. On 16 September at 1800 h a group of tahr was just moving from view around a ridge about 200 m across a valley from my observation point (Fig. 4). Abruptly their attention focused into a small gully below and beside them, and they clustered together giving the characteristic whistles. A few seconds later a spotted leopard emerged from the bottom of the gully, with a tahr young, apparently already dead, grasped by the throat. The leopard paused to look back at the clustered group of tahr, and then continued down and across the slope, dragging its kill between its forelegs. The leopard then moved into a nearby shola.

Upon investigation of the kill site, I flushed the leopard down into the shola. The next morning, I located the young, about 100 m further down. It had not been eaten, and the tooth marks on the throat were the only injuries. The leopard's left canine had penetrated below the left ear, and the right canine, just at the back of the mandible. The leopard's lower jaw had clamped on the throat, probably causing death by strangulation. There was considerable internal hemorrhaging but no external bleeding.

The practice of dragging the kill into a nearby shola appears to be typical for leopards.



Fig. 4. Hillside showing location of Nilgiri tahr young leopard kill on 16 September 1980. K: where kill was made. Arrow: direction of movement of the tahr group when kill was made. H: where kill was made. H: where kill was made. S: path of the leopard carrying the young with stopping points marked.

Game guide R. Mudhuvan recounted a nearly identical incident to me. I also found a male tahr which had apparently been killed by a leopard. The leopard had started to drag it down the slope. However, the tahr's horns and chin had become wedged between two clumps of *Chrysopogon zeylanicus*, and the leopard had fed off the hindquarters in the open. However, after I collected the head, the leopard returned, and dragged the carcass to the brink of some steep slabs, and let it tumble to a patch of forest below. Sign showed that the leopard proceeded to drag the carcass a few meters into the shola, and then fed on it on several successive nights.

In addition to tahr, a leopard was observed stalking sambar on one occasion, and prey remains in leopard droppings indicate that sambar, Nilgiri langur, and barking deer are important prey for the leopards at Eravikulam (Table 2). Leopards clearly have the most diverse diet of the predators in the area. Leopard droppings from the Grass Hills indicate that they also prey on gaur calves, as five of the six droppings contained their characteristic light brown hair. On the other hand, all of the dozen leopard droppings I collected in tahr habitat in the Mukerti area of the Nilgiri plateau contained tahr hair.

Asiatic wild dog

Unlike tiger and leopard, all indications are that wild dog are not resident within Eravikulam National Park. Prior to 1981, I encountered them on only three occasions, which consisted of sightings of a single dog, a pair, and one trio. The first evidence that a pack was present was when a sambar kill was made near Eravikulam Hut around the first of the year (1981). They continued to be active in the area until the end of the study in September 1981. According to Game Guide R.

Mudhuvan, wild dog in the area follow a vertical migration. He told me that for about the last 5 years large packs of 20-25 have moved up from the lowlands in the vicinity of Chinnar, to the northeast. The dogs reportedly split up into smaller groups in the high country, and stay 6-8 weeks before returning to the lowlands. This pattern was said to be repeated about every six months. I was unable to confirm this pattern, but the lack of encounters for extended periods indicate that the wild dogs spend a large proportion of their time elsewhere. Despite this short term of activity, wild dog were encountered more often than both tiger and leopard (Table 1), an indication of the wild dog's diurnal habits.

Most sightings were of the entire pack of nine dogs (Table 3). Wild dog do not show a predilection for roads, and their tracks were rarely encountered. Unlike the felids, wild dog did not leave scrapes, but they did occasionally deposit feces in group defecation sites.

Also, unlike felids, wild dog made no attempt at concealment, but approached their prey openly. By the same token, tahr did not show a very pronounced reaction to wild dog, as the following account from my field notes illustrates:

At 1143 h on 19 May 1981 a few dozen tahr are on the slopes of Eravikulam Malai. They are about 120 m around the corner from the rock slabs on the east end. Moving in a single line, nine wild dogs traverse the slope about 100 m below the tahr. One dog is out in front, as five of them rest at a gap in a subsidiary spur. The lead dog continues ahead as the tahr stand and watch and give a few whistles, 1147 h. More dogs come onto the crest of the spur, and one dog cuts off to the west, as the main body remains clustered at the gap. The tahr just stand above, 1153 h. A couple of the dogs start zig-zagging up the hill towards the tahr. At about 30 m the first tahr turns to move off, while most just stand. The topmost dog gallops up the slope and all the tahr now start moving, and then

gallop around the corner. Only one dog continues the pursuit just 5-6 m from the last tahr. The second of the leading dogs turns back toward the others scattered 40-60 m below. As the only dog near the tahr approaches, two straggling tahr stand and watch, one looking back over its shoulder, the other facing the dog. As it runs towards them, the tahr turn only when it approaches within about 1.5 m, and take flight. The dog runs along with them, keeping parallel and above. Tahr on slabs above stand watching. At 1202 h one of the dogs still below at the gap in the spur initiates the pursuit of a sambar doe and fawn, and all the dogs scattered above come down to join in (see below).

Nilgiri tahr are also capable of fending off attack by wild dog. This was demonstrated by a dark brown male earlier on the same day. The dogs came across the base of Eravikulam Malai at 1110 h, surprising some tahr in a gully low down on the mountainside. Several tahr took flight across to the east, but one dark brown male climbed onto a small rock projection and turned to face the two dogs that approached him. Wild dog and tahr faced each other, about 1 m apart, the tails of the dogs waving high in the air, as a third dog joined them. Meanwhile two of their companions had chased another tahr off to the east, and leaving the male, these three turned to follow. The male then moved to another slightly higher outcrop. As some of the pack moved down onto the grassy flats just below, two dogs returned to the first boulder, and then up to the new location of the male. The tahr moved out onto the small (c. 2 m²) flat top of the projection, and whirled to present horns to the first wild dog to arrive. More dogs arrived, and the tahr continued to stand facing them as they crowded around the entrance onto the flat top of the boulder, 1119 h. Two dogs dropped down the side in an apparent attempt to find a way up the back side of the boulder, without success, and the dogs departed at 1120 h. The dark-brown male left

the rock projection and moved west and up the slope at 1123 h.

However, one should not infer from these accounts of the tahr's mild reaction and successful defense that wild dog are not a threat to tahr, as quite the opposite is the case.

17 July 1981. At 0750 h a wild dog arrives from west disturbing a large group of tahr at an artificial salt lick at the base of the south side of Eravikulam Malai. As the tahr take flight across the slope to the east, the balance of the pack arrive and quickly closes in on a lagging female tahr. First one, then a second dog bite and hold the back of the female's thigh, greatly slowing her progress as she makes no apparent move to defend herself. A third dog runs around the front and grabs her by the nose, hanging onto it as she struggles to remain upright. After about 1 min, she is pulled to the ground, as tahr and sambar watch from a distance, although none give alarm calls or whistles.

As two of these dogs commence feeding, one of the three dogs leaves the fresh kill and runs up the slope towards an isolated female tahr standing on a rock slab. The female turns from the approaching dog, but runs across the slab only when nipped in the flank. The dog appears hesitant to cross the wet slabs and turns back down to the kill, as the rest of the tahr and sambar move off to the east.

Now, 5 min after the wild dogs first appeared, it becomes evident why only three dogs attacked the female. Four more are feeding on another kill, a tahr young, about 150 m to the west. Another two dogs are feeding on a third kill, also a tahr young, about 75 m below the second.

The manner in which Asiatic wild dog kill sambar is quite different. This is largely due to the sambar's propensity to take flight into water when pursued by wild dogs. An example of this is the pursuit which terminated the wild dog — tahr interaction on 19 May 1981 described earlier.

At 1202 h the lowest wild dog of the pack has remained at the crest of a spur emerging from the south flank of Eravikulam Malai. After looking intently down into a shola hidden from my view, it suddenly gives chase as a sambar

doe and fawn emerge. The rest of the pack immediately turn down to follow as the leader pursues the doe and fawn down the side of a grassy ravine, rapidly closing the sambar's initial 60 m lead. The doe is trotting surprisingly slowly, keeping behind the fawn. The dog passes the doe and cuts in toward the fawn, at which the doe lowers her head, muzzle and neck stretched forward, and rushes the dog, cutting off its attack. The sambar reach the valley floor, and turn up along the grass flats beside the stream. The same sequence of attack by the dog and rush by the doe is repeated, and the wild dog stops. The doe also slows, and then stands briefly before making another rush at the dog, kicking at it with her foreleg. Another two dogs arrive, and as one of them approaches from the other side, the fawn takes flight up the valley as the doe follows. The three dogs now flank the doe, alternately moving in toward the fawn and being repelled by the doe, as the balance of the pack arrives and the flight stops. The dogs continue to harry the fawn, avoiding the charges of the doe, but as one dog rushes in, the fawn turns and takes flight back down along the stream, with one dog in close pursuit. The doe quickly reestablishes her position between the fawn and the dog, but as another dog veers in from the side, the fawn turns and leaps off the meter high bank into the chest deep water. The doe follows, and then immediately turns to face the dogs as the fawn moves to the far side of the 6 m wide stream. During the whole chase two dogs, 3/4-grown pups, have remained behind. 1208 h.

An apparent stand off followed as the doe continued to face the dogs repeatedly sending up sprays of water as she stamped her foreleg, and cutting them off when one or two of the dogs entered the water to approach the fawn (Fig. 5). The sambar seemed to have the advantage, as she could move quickly in the meter deep water, whereas the dogs were obliged to swim. Whether this was true, however, could not be ascertained as observations were terminated by the arrival of four park visitors at 1221 h. Seeing them, the wild dogs abandoned the sambar and climbed up and over Eravikulam Malai.

However, the conclusion to a similar chase was witnessed in Turner's Valley on 27 January 1981. At 1749 h, from a vantage point about 1 km from and 400 m above the river my attention was drawn by a high squealing noise, the "whistling" wild dog sometimes give when pursuing prey (Prater 1980). At that distance I could make out a sambar (which proved to be a yearling male) being attacked by several dogs in a pool in the river. More dogs arrived and entered the water as the thrashing sambar moved under an overhanging tree. When they emerged, several dogs were clinging to the yearling's head. A sambar doe then arrived from the same direction as the others, entered the water, and reared up to come crashing down to strike the dogs with her hooves. Another two dogs arrived and the doe turned toward them, holding the low-stretched threat display and stamping her foreleg repeatedly in the water. One of the newly arrived dogs then joined the melee in the water, as the doe continued her nose to nose face off the dog on the bank. Seeming to find his footing, the yearling male rose up twice in an apparent attempt to shake loose the dogs clinging to his head, apparently grasping his ear and top of muzzle. This struggle continued for several minutes until the yearling ceased struggling at 1752, as the doe continued to direct her attention exclusively toward the one dog on the bank. The wild dogs then pulled the yearling to the water's edge and evidently began feeding. The yearling made one more attempt to rise, only to be pulled down again. The doe remained there as the dogs fed.

These accounts are apparently not exceptions, but the rule, as all of the 13 sambar killed by wild dog were in or near bodies of water. In the incident recounted above, this did not appear to be a result of choice by the

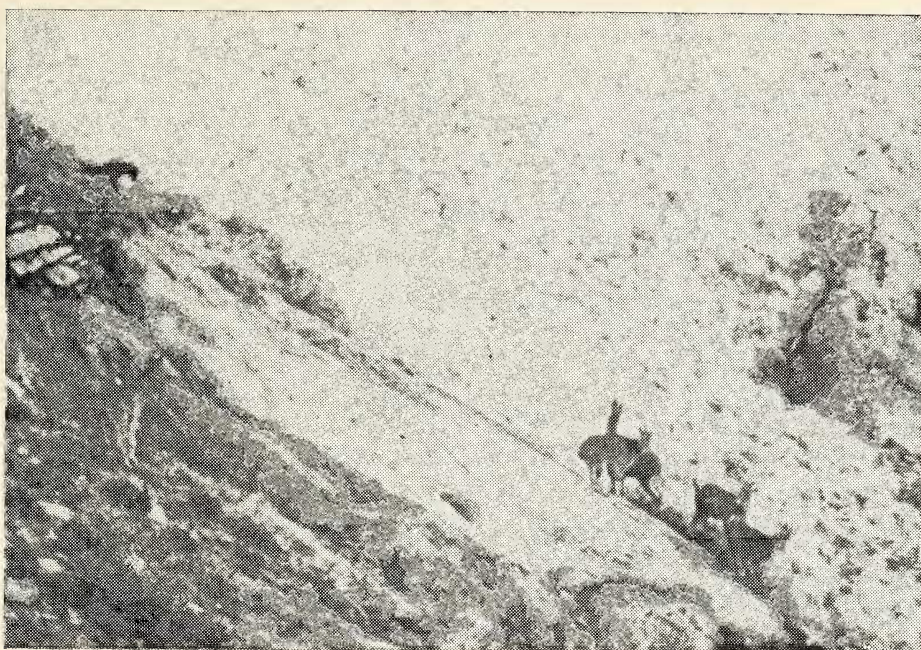


Fig. 3. After an unsuccessful pursuit by the leopard, Nilgiri tahr continue their surveillance of it on rock slabs, 22 May 1980.



Fig. 5. After a chase, a pack of Asiatic wild dogs converges on a sambar doe and fawn in a stream. The fawn is partially obscured by the water sent flying as the doe stamps forcefully in the water, and threatens a wild dog. Members of the pack are indicated by arrows.



sambar, or else the sambar would have entered the water at the first opportunity instead of fleeing along the bank. Rather, it appeared to be a result of the sambar's tendency to run down hill when pursued. This brought it to the proximity of water, and the pursuit by the dogs seemed to be the immediate reason for entering the water. The thesis that the sambar's flight only incidentally ends in the water was shared by Burton (1940), but contrasts with Johnsingh's (1983) observations. He noted sambar running up over embankments to enter water when pursued by wild dogs on six occasions.

Once in the water, however, sambar seem inclined to remain there. The sambar in the

first account could have easily continued their flight onto the other bank. This tendency was shared by a very young fawn I disturbed early one morning in January. It ran to a nearby stream and refused to leave the cold water, despite my close approach.

The ready willingness of sambar does to defend their apparent offspring was also quite evident in these accounts. However, they seemed to have considerable difficulty in doing this effectively. In the first account, this was primarily a consequence of the fawn's reaction of moving away from the attacking dogs, even when this took it away from the doe. As a result, the dogs were able to separate them, at least momentarily. In the second account,

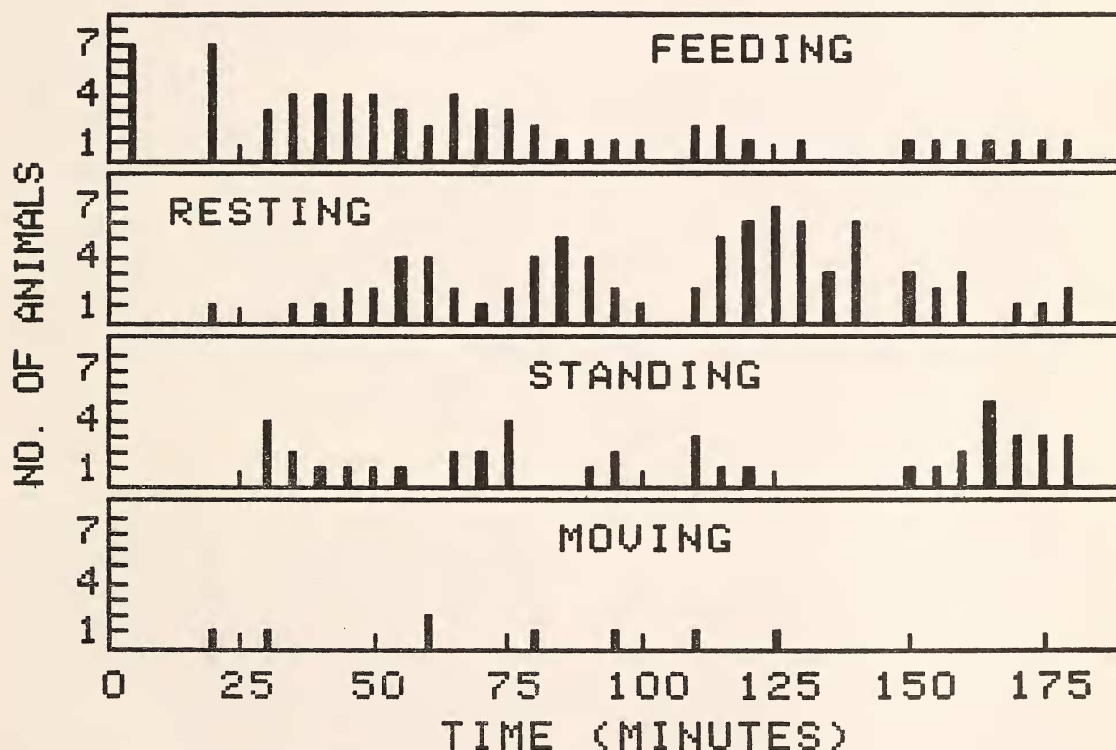


Fig. 6. Number of Asiatic wild dogs visible in each activity in instantaneous time samples after a adult female Nilgiri tahr kill. Starting time: 0645 h, 21 May 1981.

the initial spirited defense was defused by the doe's preoccupation with one single dog, leaving the balance of the pack to dispatch the yearling. An effective defense then, would require closer coordination of the doe and her offspring.

Once the prey was down, wild dog did not employ any specific killing strategy. Rather, they commenced feeding immediately. However, one adult female tahr was pulled down, and then dragged 20 m down the slopes as the dogs fed. Later examination of the kill site revealed a short section of windpipe, suggesting that soon after she was down, one dog attacked her throat. However, this may have been fortuitous as the dogs appeared to begin feeding at any available area. Johnsingh (1983) reported no throat wounds in 40 fresh wild dog prey he examined.

As Johnsingh (1983) has noted, wild dog consume their kills rapidly. When the pack killed an adult female tahr at about 0645 h, I recorded the activity of all visible dogs in instantaneous time samples (Altmann 1974) at 5 min intervals. As shown in Fig. 6, within a half hour, some dogs had left the kill to stand and then rest in the vicinity. Within 1 h and 15 min, most of the prey had apparently been consumed, as only one or two dogs fed from then until they left the kill. Similarly, when the triple kill was made on 17 July 1981, most of the dogs left the tahr young kills after only 20 min, and the adult female kill elicited little interest after 1 h.

Dogs remained alert while resting or standing within the first hour after the kill was made (Fig. 6) and generally oriented away from the prey. This contrasted with those resting 2 h after the kill, when the dogs lay their heads down. It is possible that after the initial feeding bout, dogs maintain a look-out for disturbances. This suggestion is further sup-

ported by the manner in which the dogs seemed to "take turns" feeding and watching, as a sitting or resting dog left its position when another dog left the kill to rest or stand.

No single individual led the wild dog pack in initiating departure from the kill, either to drink or to leave the area. Rather, one dog made a move in a particular direction, but then did not continue if the rest of the pack did not follow. Indecisive individuals sometimes stood looking in the direction being considered, which is indicated in Fig. 6 by the greater number of dogs standing around 80-90 and 160-180 min after the kill. This interplay of "leading" and following was demonstrated as the pack left the adult female tahr kill.

At 0948 h one dog abruptly moved west, walking and trotting. He was followed by a second dog at 0951, and both sat on a knoll about 100 m away. At 0952 h three more started west at which time one of the "leaders" resumed his westward move. However, one dog sitting east of the kill was looking east as if intending to move in that direction, but then turned and moved west, as did another dog (0952 h). By the time the seventh dog was on the knoll, the leader was 100 m ahead (0953 h), but two that had moved west earlier then turned back east, and one that was resting midway turned to the south at 0954 h.

As this one dog continued south, three from the west arrived back below the kill. At 1001 h another dog moved south as the first one kept going, but they then started back north at 1004 h. A third dog also came south and sat at the rim of a gully with one of the previous two as the third dropped into a gully, but all three turned back north at 1008 h.

At 1012 one dog started west again, but stalled. Another dog started east, paused to look over his shoulder, and turned back west (1016 h). However, another dog moved abrupt-

ly east and others followed at 1017 h. As one of these started along a trail to the east, three dropped down into the shola (1026 h), and two more rose to move that way. At 1033 h, eight dogs emerged from the shola and rested, not far from the kill.

One of these dogs then started to the east again at 1107 h. Five more followed, and joined it on a knoll (1109 h), and a seventh also came over. Then, at 1124 all seven moved single file back to the west, passing below the kill. As they moved on, the last dog came galloping 200 m behind (1129 h).

While I was not able to keep track of all movements on the hillside, this departure from the kill was clearly prolonged and uncertain in direction as over 1.5 h elapsed, including at least six false starts before the final direction was determined.

Evidence from scats (Table 2) indicated that sambar were the primary prey of wild dog, and that tahr and barking deer were also taken on occasion. They also will evidently eat an occasional lizard or snake when the opportunity arises, although I never saw them hunting them. Like most predators (Schaller 1967, Kruuk 1972), wild dog will scavenge when given the opportunity. This same pack consumed a tahr carcass known to be a few days old.

Jackal

Jackals were seen occasionally, sometimes in pairs, but more commonly alone (Table 1). Many of these sightings were within tahr home range (Table 1), but jackal were never seen pursuing tahr. Probably the only time jackals could prey on tahr would be during the first week or two after the tahr's birth, as older tahr would most likely be able to defend themselves from attack. However, there was no indication that even this occurred, and the

only observations I had of them hunting were of small grassland animals, probably rodents. On a few occasions jackals passed close to groups of tahr, but neither species showed much interest in the other.

Remains of prey in jackal droppings (Table 2) indicate that jackal use a wide variety of food sources, but depend heavily on rodents. The one dropping containing gaur hair was found in proximity to the gaur killed by a tiger described earlier. This was obviously a case of scavenging, and the same is presumed to be the case with the other ungulate remains found in jackal droppings.

Humans

The potential for human impact on ungulate prey populations in Eravikulam National Park is great considering the small size of the park and the proximity and concentrations of human settlements along the southern and eastern boundaries (Fig. 1). Most of the humans I encountered were collecting plants such as *Drosera peltata*, and these sightings are not included in Table 1. Of the eight parties seen, six contained men armed with muzzle-loaders. I heard one or more gunshots on 11 occasions during the course of the study, giving some indication of the frequency with which these guns are used. Domestic dogs were also used in hunting, and three of the parties were accompanied by dogs. Hunting in Eravikulam was presumably for meat.

One party of men unknowingly demonstrated their method of hunting tahr to me. On 21 February 1980, five men, two of whom were armed, accompanied by five domestic dogs were first seen along the northern flank of Inaccessible Valley at 1115 h. After apparently not locating suitable prey on the slopes above, the men moved down toward the valley floor, and out of sight at 1130 h. Then

at 1145 h the two armed men and one of the dogs reappeared traversing along the top of a low set of cliffs where they were attempting to reach a lone saddleback. However, before the lower men could signal those up top, the saddleback made its way off to the side and out of sight. The men reassembled and moved off in the direction the saddleback had gone at 1239 h. In light of the behavior described earlier for the dark brown male tahr confronted by wild dogs, it appears that these men anticipated a similar reaction, and using their domestic dogs to confine and occupy the tahr, hoped to be able to approach and shoot it.

This is evidently what transpired in another incident on 16 July 1981. I first heard dogs barking, evidently in chase, and a shot fired across Turner's Valley at 0935 h, but mist obscured the view. The barking resumed at 1002 h, followed by another gunshot. The mist then cleared at 1014 h, and I saw five men, two of them armed, dropping down a ridge on Poola Malai, to a point where it ends in a set of cliffs. The men apparently saw me as well, as I was sitting in the open about 1 km across the valley, and they moved down beside the cliffs to the edge of a strip of shola, apparently hiding. One of their dogs, however, moved up to where a saddleback was lying in a shallow gully. Eventually one man crawled up and dragged the saddleback down to the shola, which was the last I saw of them.

If my deductions are correct, one collared female was shot a day or two before I found her on 03 May 1981. The only marks on her were a pencil-sized hole in the middle of her right side, and some flesh missing from her udder and inguinal region, which probably corresponded to the exit point. (The pack of wild dogs scavenged this kill before I had the

opportunity to perform a more complete necropsy).

Tahr are also poached using wire snares. I found one such setting at the southern end of the park, made of stiff wire about 3 mm in diameter. A large light brown male showed up in the Vaguvarrai home range wearing a collar of similar wire, and one female in a large mixed group in the Grass Hills sported a colorful wire noose.

Although I have scanty data on interactions between tahr and poachers, I had ample opportunity to observe their reactions to my own presence. At the onset of the study, tahr showed a flight distance from me of about 300 m, and individuals outside the Vaguvarrai intensive study area retained this response through the course of the study. Tahr moved away at even greater distances, but then usually at a walk. When surprised at closer proximity and when the nature of the disturbance was plain, tahr took immediate and direct flight. The nature of this flight was as if the tahr had two priorities: (1) to increase the distance between themselves and the human, and (2) to get out of sight. In cases where these two aspects conflicted, the later seemed to take precedence. However, I never saw tahr move closer in an attempt to get out of sight, but they did sometimes move at right angles to the line between us if that took them immediately out of my view. If tahr were away from the typical flight cover of steep cliffs and slabs, moving in the direction of these also seemed to be a priority. Once out of sight, tahr usually walked quickly to slabs or cliffs if none were in the immediate vicinity. Once on the slabs, they usually stopped and stood, the gray pelage of the females and subadults closely matching the color of the gneiss. They often did not move further than the nearest steep terrain upon first being

disturbed, but moved much farther if disturbed a second time. On rare occasions tahr took flight across the open plateau. The longest flight I recorded was about 1,200 m, across the north side of the top of Kattu Malai.

Sambar also fled from humans at distances up to 300 m. Their response differed from that of tahr primarily in that sambar took flight into sholas, rather than to cliffs.

CONCLUSIONS

In Eravikulam National Park, tiger, leopard, and jackal may be considered residents. While it is not possible to state their abundance in absolute numbers, the evidence indicates that tiger are few, whereas leopards are more numerous. Asiatic wild dog and humans are temporary visitors to the park, and their numbers fluctuate accordingly. Wild dog appear to visit the high country, including the park, for several months at a time, whereas human visits are presumably of a duration of a few days or less.

It is clear that tahr and sambar react quite differently to the different predator species. Stalking predators, (leopard and tiger) are kept under surveillance until they leave the area, whereas wild dog do not elicit a strong reaction. A similar difference in the reaction of prey species to stalking and non-stalking predators was noted by Schaller (1972) in the Serengeti ecosystem. The tahr's flight distance from man is commensurate with the distance at which man can inflict damage on tahr. The manner of flight is also in keeping with method of attack, as line of sight and "line of bullet" are essentially the same. Thus, one cannot specify a generalized "predator response" for tahr, because the response varies significantly with the predator involved.

The clustered, agitated surveillance of a

predator in the open exhibited by Nilgiri tahr has been reported for other ungulates, notably chital (*Axis axis*, Muckenhirn in press) and Thomson's gazelle (*Gazella thomsoni*, Walther 1969). While Muckenhirn refers to such behavior as mobbing, Walther terms it a fascination behavior, stating that it is similar to mobbing, but lacks aggressive intent. Nilgiri tahr and chital also showed no indications of aggression in this context and therefore, the term mobbing is somewhat misleading, as it definitely connotes an aggressive response. With this in mind the continuum of antipredatory defenses proposed by Berger (1979), from retreat through stare, 'curious', follow, and attack seems somewhat questionable. Certainly, the continuum exists with reference to the physical movement of the prey relative to the predator, but from a motivational standpoint the connection is less certain. Contrary to expectation, a tahr (and presumably a chital or gazelle) engaging in 'curious' following is not on the verge of attack, but on the verge of flight, as was so readily evident in the encounter with the leopard on 29 April 1980 described earlier. It is also appropriate to distinguish offensive and defensive aggressive responses against predators as Walther (1984) has done for intraspecific social behavior. While the behavior of a sambar doe rushing towards a wild dog, giving a low-stretch threat and kicking with the forelegs, is clearly offensive, the male tahr that held off several wild dogs was using the horn threats defensively. This difference is also difficult to incorporate into Berger's continuum. Rather it seems appropriate to consider the various antipredator defenses as discrete responses to the particular prey, predator, and circumstance.

The contrast between the male tahr's successful defense against several wild dogs and